SOME DESCRIPTION

OF

THE METHODS

USED IN

POINTING GUNS

AT SEA.

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TO

THE RIGHT HONOURABLE

SIR JAMES ROBERT GEORGE GRAHAM,

BART., F.R.S.

FIRST LORD OF THE ADMIRALTY,

&c.

THIS ESSAY IS DEDICATED

BY PERMISSION,

AND WITH GREAT RESPECT,

BY

HIS MOST OBEDIENT,

AND VERY HUMBLE SERVANT,

THE AUTHOR.

PREFACE.

THE following little Essay is written for the use of young officers in the Royal Navy during some part of their first two years' service on board ship: it is not given as a treatise on Naval Artillery, but as a short introduction to that science.

The Author begs to observe that he has only intended to describe, without any exclusive advocacy, the methods used in pointing guns at sea; but besides pointing them well, the rate proper to fire them seems not unworthy of notice; and although *that* is not the subject of which this work proposes to treat, yet the following anecdote may not much encumber a Preface, and seems to afford valuable hints for a consideration of the question.

A French artillerist recommends that, when the enemy is distant, the firing on him should be conducted slowly (lentement); when near, quickly (vivement); when close, precipitantly (précipitamment). This being repeated to an experienced officer in the British Navy, whose knowledge in these matters well enabled him to appreciate the

exact value of the above saying, he promptly rejected the *slow* and *precipitant*, and in a few, but expressive words, pointed out the *quick* rate of firing (far the most eligible to be adopted) as combining the deliberation of the first, without its discouraging feebleness, with the energy and effect of the third, unaccompanied by the hurry which the French word "précipitamment" certainly implies.

It is to be presumed that young officers will not let pass any opportunity that may arise of obtaining some of the ample information which is afforded by the establishment under Captain Hastings, on board his Majesty's ship Excellent, at Portsmouth, where many of the objects of naval gunnery are constantly the subject of extensive practice, and where almost all are in turn brought under trial and investigation.

SOME DESCRIPTION,

&c.

MILITARY projectiles, whether shells, round shot, case shot, Congreve, and also signal rockets, have their range and time of flight evidently determined by the general laws of mechanics, and by these only can they be explained: where this cannot be done, the deficiency arises from some imperfect application of them; but as a theoretical acquaintance with these matters is not attainable by many who are employed in the service of warlike machines, little other attempt will be made, in the few pages to which it is intended to restrict this Essay, than to explain, plainly and shortly, facts which seem most requisite to be understood.

Shot and shells, of every nature, are, on leaving the piece of ordnance from which they are fired, acted on by two forces—one called the projectile force, arising from the charge of powder; the other, the force of gravity. The first alone would

impel the shot in a straight line in the direction of the gun when it is fired (as *a b*, fig. 1), whilst, by the latter, the shot is constantly attracted towards the earth, in the direction of the arrows: these two forces, acting at the same time, cause the shot to describe a curved line (always below the direction of the bore or axis of the piece, *a b*) until it meet the ground or water somewhere, as at *c*. It must be remembered also, that the air resists the progress of the shot, and causes the range to be considerably shorter than it would be if the shot were not so resisted. Probably the resistance of the air does not act in a plane parallel to the horizon, as from 3 to 4, but is more nearly opposed to the direction of the shot in every point of its curvilinear flight, as from *c* to *d*. It is known from experience that guns throw their shot in *some* proportion farther as the axis points upward, also as the gun is raised bodily to a greater height above the plane over which it is fired—as from a lower to an upper deck, or from the bottom to the top of a cliff, &c.; the almost obvious reason of which is, that, in *either* of the above cases, the shot has farther to fall before the action of gravity can bring it in contact with the plane over which it is projected, be that plane the earth or water.

There are, therefore, two modes of extending the range of a shot *without increasing the charge of powder*, viz.—by raising the piece to a higher level, or by giving its axis greater elevation*.

From the last-mentioned circumstance, instruments have been invented, by means of which guns may be discharged at sea at any required elevation, *notwithstanding the motion of a ship.* All such sights, though they are varied even to perplexity *in form*, may be comprised under two descriptions, 1st, Those which act by weight, or, more correctly speaking, by gravity—these may be called GRAVITATING INSTRUMENTS; 2d. Those which may be considered as tangents to some radius, and are, therefore, called TANGENT SIGHTS: in these latter may be included all Dis-

* The increase of range, by reason of an increase of elevation, has its limits: these are pointed out in Hutton's Mathematics; no apology is offered for making an extract on the subject.

——"It will be found that the greatest range, instead of "being constantly that at an elevation of 45°, as in the para- "bolic theory, will be at all intermediate angles between 45° "and 30°, being more or less both, according to the velocity "and weight of the projectile: the smaller velocities and "larger shells ranging farthest when projected almost at an "elevation of 45°, while the greatest velocities, especially with "the smaller shells, range farthest with an elevation of about "30°, or little more."

parts, Congreve's, Millar's, Hookham's, and many other constructions of sights on the tangent principle.

OF TANGENT SIGHTS.

THE breech of a gun is evidently larger than the muzzle; therefore, if a gun (see fig. 2.) were pointed at an object o, by looking over the surface of the metal, the bore would not point at the object, but above it, (as at *e*,) and so much above it, that if two vessels were to point their guns in this manner at 300 or 400 yards distance, the shot would never take effect on, but pass above each vessel's hull some feet; this source of error is avoided by fixing a piece of metal on the upper surface of the gun, at any convenient part, of such height, as will make the height there, exactly level with the base ring, (see *d*, fig. 3.) This contrivance is called a dispart, or sometimes, a point blank sight; but as sights near the muzzle, on board of ship, would probably be destroyed by the effects of the gun's recoil, they are not placed before the second reinforce ring, they must be made and fixed very accurately and firmly.

Method of finding the Height of a Dispart for any Gun.

A pair of callipers and a two feet scale are necessary to perform this operation.

1st. Measure the diameter of the base ring (set it down.)

2d. Measure the diameter of the gun at the part where it is intended to affix the dispart, (write this diameter also down). Subtract the less from the greater, and divide the difference by two, which will be the required height for the dispart.

Example.

Required the height of a dispart to be fixed on a 24 pounder gun,

Diameter of the base ring	20·8
Ditto of the reinforce ring	16·8
	2) 4.
	2 inches

two inches being the height of the required dispart to be placed on the second reinforce ring*.

The height of the dispart being now found, it may be made of any convenient form.

* In carronades, Congreve guns and some others, the vent patch rises higher than the base ring: when this is found to be the case, the height of the patch in question must be added to the dispart found by the above rule.

To fix the dispart, a line must be drawn from the notch on the muzzle, to the notch on the base ring; the centre of the bottom of the dispart must be placed exactly on this line, and there be screwed or otherwise firmly fixed.

Disparts are not always of this construction; sometimes they are connected with the base ring, and not moveable (as *a*, *b*, fig. 4); and in other connected disparts, the end next the breech is made to be raised upwards, (as *c*, fig. 5): this sight then becomes what is called a straight edged, or Congreve sight. In other constructions, the dispart is detached and fixed, and a bar is made to be moved upwards at the breech: this sort of sight the French call a "hausse;" in the British service, it is called a TANGENT SIGHT, and is usually, if not always, fixed to field-guns without, and to howitzers with a dispart, (in ship-guns it is always used in conjunction with a dispart, as shown, *b*, *d*, fig. 3.)

The Inspector of Artillery having introduced the latter (with some alteration) in the naval service, they are known by the name of Millar's Sights: all the above are, in fact, *Tangent Sights*.

When a gun is pointed *by means of a dispart*, at any object, either on the same, or a higher, or

lower level than itself, it is said to be pointed point blank at such object, as point blank at the blank hammock rails, or point at the water line, &c.

Of Tangent Sights, there are several kinds, as,

1st. Congreve's Sight, fig. 5.

2d. Millar's Sight, fig. 3.

3d. Hookham's Sight and Congreve's *Disparts*, } figs. 10, 11 & 12.

The Congreve Sight (fig. 5) is furnished with a ring at each end, having two wires across each; these rings and wires are intended to permit the object being brought with greater accuracy in line and elevation: some persons find a difficulty in using sights with these rings and wires, but others do not experience this difficulty, and prefer them.

The Congreve Sight has an index (*i*) fixed to it (fig. 5), to show the number of degrees, &c., to which it may be elevated; these degrees are longer as the length of the sight increases.

The following is a very simple, practical and nearly approximating rule, for finding the length of a degree for any Tangent Sight, whether Congreve's, Millar's or Hookham's.

If the index is placed between the extremities

of the sight, multiply the distance in inches, from the index to the pivot on which the sight turns as a radius, by ·0175: the product will be the length of the degree required, in inches and decimals of an inch.

If the index be at the extreme end of the sight, multiply by the whole length of it for the answer.

Example I.

Required the length of a degree to be marked on the index of a Congreve sight.

i to *k* is 17·5 inches.
Multiply by ·0175

875
1225
175

·30625 Answer,

or three-tenths of an inch (any less decimal than the hundredth part of an inch is neglected, being too small to be measured on a scale.)

Example II.

Required the length of a degree to be marked on an index for Millar's sight; here the index is at the extremity of the sight, and the distance to be measured is from *b* to *d*, fig. 3, which is 4½ feet, or 54 inches; this, multiplied by ·0175, gives ·945, that is to say, nine-tenths, and four hundredths of an inch for the length of the required degree; but General Millar's tangents are not graduated to degrees, they are marked in divisions, corresponding to *distant* charges and ranges, as 400, 800, 1200 yards, &c.

Example III.

Required the length of a degree to be marked on a Hookham's sight (fig. 12); here the index, as in Millar's sight, is at the extremity, the length (from *b* to *d*, fig. 3) is 54 inches; this, multiplied by ·0175, gives as before ·94 for a degree.

It may be observed that this sight (Hookham's) affords the means of elevating the gun by its index being moved downwards from PB, and not by its being moved upwards; the use, however, of such sights is limited to the extent of the *angle of dispart*, to whatever that angle may amount.

ANGLE OF DISPART.

It has before been observed, the breech being larger than the muzzle, that if a gun were pointed by bringing the surface of the metal in line with the object, the bore of the gun would not point at, but above the object; now the angle or number of degrees the bore of the gun would point above the object aimed at, when laid by the surface of the gun, is the Angle of Dispart; and the line, because it is taken by looking along the surface of the metal, is termed Line of Metal.

To find the Angle of Dispart.

1. Find the length of the dispart in inches as directed in page 11.

2. Find the length of a degree corresponding to the length of the gun.

3. Divide the dispart by the length of the degree thus found.

Example I.

Required the angle of dispart for a gun, the length of which is 9 feet 6 inches, the diameter of the base ring 20·74 inches, and that of the muzzle 15·18 inches.

1. Diameter of the base ring . 20·74
   Ditto of the muzzle . . 15·18
   2) 5·56
   Height of the dispart in inches 2·78

2. Length of the gun 9½ feet, or . 114 inches.
   ·0175
   570
   798
   114
   Tangent of a degree for a 9½ ft. gun 1·9950

3. Dispart.
   1·995) 2·7800 (1·39 Answer (that is, one degree, three-tenths, and nine-hundredths).
   1 995
   7850
   5985
   18650
   17955
   ·695

Example II.

Required the angle of dispart of a 32-pounder carronade,

diameter of the base ring being 17·51, that of the muzzle 12·54, and length of the carronade 45 inches.

1.

Base ring	17·51
Muzzle	12·54
2)	4·97
Dispart =	2·485

2.

·0175	Inches
45	
875	
700	
·7875	= tangent for 1° for the carronade.

3.

·7875)	2·4850	(3°·15	Answer, angle of dispart three degrees, one-tenth, and five hundredths.
	2·3625		
	12250		
	7875		
	43750		
	39375		
	·3375	&c.	

We have now described Tangent Sights, and will proceed to some explanation of GRAVITATING INSTRUMENTS (see figs. 6, 7, 8, and 9), where some of them are drawn: viz.—

1. Gunner's quadrant (fig. 7).

2. Gunner's quadrant, equipped with spirit levels instead of a plummet (fig. 9).

3. Pendulums to be affixed to the trunnions of a gun (see *b*, fig. 6).

4. A side scale (see 5, fig. 6).

5. Pendulums to ascertain the heel of a ship (see fig. 8).

7. Graduated coins.

Some of these have been used for experiment, in harbour, and, in conjunction with fig. 8, to level the guns on their carriages, and to mark the coins to correspond with the guns at P B *with the horizon*, when the ship is motionless and on an even keel; the coins are then marked with degrees for elevating and depressing the gun according to any heel of the ship that may be indicated by the pendulum (fig. 8): by this means, when engaging in the dark, or when very much obscured by smoke or fog, the guns may be levelled to point blank, when, from the above circumstances, tangent sights cannot be used.

The side scale is a species of graduation upon a similar *principle*, as marking the coin; the P B mark is found by the gun's being levelled when the ship is on an even keel, and remains motionless.

Degrees, ascending and descending, are marked on the scale, of a length corresponding to the radius which influences them. In the case of the side scale (as shown in 5, fig. 6), the radius is from the centre of motion of the gun (the trun-

nions) to the arc of the side scale, and *if marked on the arc, as in this plate*, the degrees will of course be all of the same length. An arrow is marked, or a painted line is drawn, on the gun, corresponding to the P B on the side scale.

The Gunner's Quadrant is used by placing the arm of the instrument along the lower surface of the bore, and the plummet will at once indicate the elevation of the piece above the horizon.

The spirit level quadrant is used by placing the arm of the instrument along the lower surface of the bore, and then, by moving the limb of the instrument until the bubble, or bead of the spirit, is in the centre of the tube, the limb will then cut somewhere on the graduated part, and show the elevation.

The pendulum (fig. 8) is used to find the heel of the ship, which is then to be compensated for by using the side scale, or graduated coin. Thus, if the pendulum showed a heel of five degrees, the weather guns must be depressed to the fifth degree by the coins or side scale, and the lee guns elevated as much. The guns on each side would then be laid level with the horizon, and doubtless, if ranging alongside an enemy, with a *steady heel*, a due horizontal discharge might thus be delivered, either to windward or to leeward:

which, however, can be equally done with tangent sights, by each captain of a gun keeping his piece point blank at the visible horizon; but in the dark, or in thick fogs, this of course cannot be effected, then coins, pendulums, or side scales may be used.

Pendulum *b*, fig. 6, is much more simple in its application; it is fixed to the trunnion, and the limb shows the variation of the bore from the level; the coin is then moved in, or drawn out, until the index points to P B, and the bore of the gun is thus at once levelled to an horizontal position without assistance from a side scale or graduated coin.

In order to fire at any required elevation with tangent sights, it is only necessary to fix the index at that elevation at which it is intended to discharge the gun, and to fire when, *by means of the motion of the ship, or an adjustment of the coin*, the object can be seen through both rings (where there are rings); and where there are no rings, as Millar's sight, when the two points of the sight and the object are in line. Perhaps it may be better to pull the trigger lanyard the *instant before* the object comes in *line*.

Much has been said as to the proper time to fire,—whether with a rising or falling roll? It

seems that the practical answer to this is very short, viz.—fire whenever you can get the sights correctly on, since, under most circumstances in action, there can be no time to select; doubtless the best time is when the ship has completed one roll, and remains for a very short time still, before she commences another; and the coins should, *when possible,* be so adjusted that the sights may be in line with the object during one of these comparatively quiet moments; but the object cannot always be seen when the vessel is in the trough of the sea. On the lee side the rising motion, on the weather side the falling motion of the ship is slowest, and on that account they may be respectively preferred, but time and circumstances do not always permit a choice.

There is a practice by pointing a gun at different heights of the enemy's mast, according to his distance; but in some cases there are no masts or high objects to point at, then a tangent sight *must* be used if the distance much exceed P B range. Some of these cases are, when engaging batteries, troops on a beach, flotilla, and steam-boats.

It will be evident, with a little consideration, that the gravitating instruments (figs. 7 and 9) can only be useful in naval artillery operations, in cases of no motion (extremely rare), or for the

purpose of being used in *conjunction* with figure 8, or some similar instrument, when levelling guns in still water, in order to mark the coins, or the side scale, which is done thus:—Fig. 8 is fixed athwart ship, in any convenient part of the vessel, so that the index may point to zero, or P B, when the ship is on an even keel; each gun is then levelled by a quadrant or spirit level; the coin and stool bed are marked by a vertical line, called P B; degrees are then marked on the coin, each side the P B line, in one direction for depression, and the other for elevation.

Fig. 8 is a pendulum to show the heel of the ship; the index moves on a graduated plate, resembling a dial-plate; the plummet, or weight, is connected with the index by a train of multiplying wheels, by means of which the degrees are much longer than they would otherwise be indicated by so short a radius as that attached to the pendulum in this instrument.

It may not be altogether superfluous to observe, that, as tangent sights are correctors of the effects of the ship's heel on guns mounted on the broadsides, no allowance must be made for that in using them; for example, if the distance be such as to require 2° elevation, and the tangent sight be so set, and the gun fired when the object is

seen in line, the gun will be discharged at 2°, whether it be fired from the lee or weather side, or whether the ship be rolling or motionless;—indeed, one great value of tangent sights consists in *this circumstance,* that the *line* and elevation are obtained by one view and operation, and are *not affected by the heeling motion* of a ship.

There are many varieties of pendulums to answer the purpose of *b,* fig. 6, and some of them rather complicated. The use of this kind of pendulum seems to be to level guns in the dark, or when obscured by thick fogs or dense smoke, and disparts or tangent sights cannot be used. The late Sir William Congreve invented a howitzer carriage, or rather bed, for boat service. The piece, being suspended by the trunnions on the trunnion boxes, was made to assume any required elevation by altering the position of a heavy weight connected with it, and moveable by a screw; the weight being moved towards the muzzle, the elevation was lessened, and increased when screwed nearer the breech. The intention of this contrivance was, that the howitzer should vibrate, and not recoil; also, that the elevation given to it should be uninfluenced by the pitching motion of the boat.

It has been said, in the foregoing pages, that

there are two methods of procuring a greater fall for the shot, and, in consequence, a greater range :—

1st. By raising the gun bodily to a higher level.

2dly. By pointing the bore upwards.

It is, however, important to be remembered, that when a gun is pointed above any object by a *tangent sight*, the range, in such cases, is (within practical limits) the same, whether the gun be on a quarter or lower deck; but it is not so when guns are elevated by gravitating instruments, for then main, middle, and lower deck guns will, respectively, have different ranges, although a gravitating instrument might *show the same degree of elevation* for each, the simple reason for which is, that a gravitating instrument indicates the elevation above *an horizontal plane on which the gun stands*, but a tangent sight indicates the elevation which the axis of the gun has above *any object* whatever, to which the tangent sight line may be directed, whether the object be on a higher or lower level*.

* It is advisable to distinguish in practice-tables, whether the guns are laid by tangent sights or gravitating instruments. In the latter case, the height of the piece above the plane should be stated, since such ranges are only true at *that* height, being longer at a higher, and shorter at a lower altitude than the one from which the table may be con-

HULL FIRING.

UNDER this head it is intended to point out the use of a dispart, or point blank sight.

When a ship, steam-boat, gun-boat, or any other vessel whatever, engages an opponent, not less than a frigate, at five hundred yards, or at a less distance, every shot may be expected to take place somewhere in her hull, provided the guns are pointed by the dispart sight at the hammock rails; the shot cannot go over the enemy's hull, since they cannot rise so high as the axis of the piece prolonged; neither can they fall short, because the height of the above-mentioned part of a frigate is about equal to the fall of the shot in the first FIVE HUNDRED YARDS. The foregoing principle may be further extended; for, on account of the greater height of line-of-battle ships, every shot fired at such, in the manner above directed, may be expected, at SEVEN HUNDRED YARDS distance, to take effect in some part of the hull: and it may be here observed, that, in either of the

structed; but if practice-tables were made from guns laid by tangent sights, these variations would not exist, and the tables in question would be more satisfactory registers of the power of the piece, and, perhaps, better guides on service. A troublesome course of practice, however, must be made before such tables could be constructed.

preceding cases, if the shot should graze a *few yards* short, they would not rise above the hull, nor would they probably lose so much force by *one graze* on the water, as to destroy their effect even against larger scantlings. It is tolerably evident that solid shot will preserve their momentum better than hollow, and larger shot better than smaller ones.

CHASE FIRING.

CHASES being necessarily made under a press of sail, the pursuing and the pursued vessels have *generally* a considerable heel; in consequence of which, the guns in the bow and stern of each are inclined to leeward from the upright position; the result of this will be, that when firing at an elevation, the shot will fall, or be apparently deflected to leeward of the object pointed at. The effect of this error may be avoided when chasing, or being chased, by the simple practice of taking care to point the bow or stern guns, as the case may be, AT THE WEATHERMOST PART OF THE ENEMY'S HULL, the sights being of course adjusted to the distance in the usual manner; or, if the sights are not used, and the method of pointing up the enemy's mast, according to the distance, with a disparted

gun, be followed, an allowance must still be made, because the *mast* inclining to leeward, the gun would be pointed to leeward, and the error the greater the higher the aim is taken.

In addition to the above causes by which shot, fired from bow or stern guns, of a vessel having a heel, are misdirected; the wind acts in the same direction, and tends to throw the shot to leeward. These two causes of error ought not to be neglected, since they operate precisely where accuracy of fire is of most importance, and their amount is *far greater* than many, who have not investigated the subject, would perhaps suspect; for supposing one frigate chasing another, the ships heeling 10°, and the elevation required for the guns to be 2°; under these circumstances, the shot would pass *eighteen feet and more* to leeward of the point aimed at, and this, too, without considering any effect from the wind, which would be considerable, on the shot.

In the preceding pages, tangent sights have been described as correcting the errors arising from a ship's motion, as it affects pointing guns*;

* Tangent sights are not *perfect* correctors of the effects of the ship's motion, even as to elevation; for there results a small unimportant loss of elevation, from a gun's being inclined from the upright, as will be noticed hereafter.

so far as relates to errors of *elevation* they may be so *considered*, but not as to those of *direction*, caused by a *heeling* motion on guns mounted at the extremities of the ship, and firing directly forward or aft, or those occasioned by a *pitching* motion on guns mounted upon the broadside; but this latter disturbance is of much less moment than that caused by the heel, since objects fired at from the broadside either present their length, or else are too near to be missed by any error of direction arising from a ship's pitching. It may be observed, that when a ship has much pitching motion (under sail), she will generally be on a wind, and *that* force, in consequence, will not now unite with the motion of the ship to throw the shot more out of its proper direction.

The following is an *approximating* theorem, which will serve to show sufficiently the amount of the shot's deviation from the apparent direction, under the different circumstances of the inclination of the plane, the gun's elevation, and the range of the shot.

Theorem $R \times T \times S = D$

In which R = range in feet
T = tangent tabular elevation
S = sine gun's inclination
D = lateral deviation from apparent direction in feet.

Example.

A ship heels over 10°; she is firing her chase guns at an object 1000 yards, or 3000 feet, distant. Required the shot's deviation.

R 3000 feet	. .	Log. 3·4771213
T tangent 2°	. .	,, 8·5430838
S sin of 10°	. .	,, 9·2396702
D = 18·191 feet, &c.	.	1·2598753

Note, 20 must be subtracted from the index.

The small diminution of elevation alluded to in the note may be shown by the following theorem, but the error is too small to require practical notice.

Theorem $T \times C = E$.

In which T = tangent of apparent elevation
C = cosine of ship's inclination
E = tangent of true elevation.

Take the foregoing example.

Then T = tangent 2°	. .	Log. 8·5430838
C = cosine of 10°	. .	,, 9·9933515
True elevation 1° 58′ 10″ (tangent)		8·5364353

Ten to be taken from the index.

An instrument was invented by Captain Dewel, of the Royal Artillery, in 1818, to correct the effect of any lateral inclination of the plane on which a gun might stand; it was, in fact, a pendulum tangent scale, freely suspended at its zero, or commencement of the scale, which was accomplished by making the weight of the instrument,

below its suspension, such as to retain the scale in a vertical position. When this instrument is applied to a gun without a dispart, it cannot of course be used for elevations below the line of metal. Some attempts have been made to adapt it to ship guns, but not very successfully.

The French Navy appear to be turning their attention to the effects of errors in *direction* of guns, arising from lateral inclination; but the mode of correction described to the writer seems to be rather too nice for practice*.

SHELL FIRING FROM GUNS.

SHELLS and hollow shot are supplied to ships carrying eight or ten inch guns.

The following precautions in the serving this nature of ammunition should, in practice, be attended to, viz.:—

1st. Whenever circumstances permit, fire a few *hollow shot*, to ascertain the proper elevation for the range of the loaded shells.

* The attentive consideration of the whole of the preceding article will perhaps lead to a conviction in the minds of those who have not previously investigated the subject, of the great importance it must be to employ the longest ranging guns for the purposes either of defensive or offensive chase, the errors from lateral inclination being the less, in proportion to the smaller degree of elevation required for the range.

2nd. Then immediately, with the elevation thus found, fire loaded shells. By attending to these two precautions, shells will not be thrown away.

3d. Endeavour to strike the object without permitting the shell to graze previously, as fuzes are sometimes extinguished by several grazes on the water.

4th. The shells are secured in boxes, the top of which being removed, the shell is discovered with the wood bottom upwards, the fuze being downwards. The box must be used as a bearer, and the shell turned from it, as hot shot are, into the gun. The fuze will now be discovered outwards ; the cap must be unscrewed, and the shell pushed steadily and firmly home with the hollow-headed rammer. The top of the box must by no means be taken off until the instant before loading, nor the fuze cap be unscrewed until the shell is fairly lodged in the bore. If the precautions here recommended be patiently and carefully attended to, there will be little chance of accidental explosion.

By the present system it is not intended that the fuze should be shortened according to the flight, but that the shell should be fired as a shot, taking the chances for its bursting as a shell when lodged.

CONGREVE ROCKETS.

THESE rockets are also called Fire-rockets, to distinguish them from Signal-rockets.

One sort of them are armed with a peculiar shaped shell at the head, and are called SHELL ROCKETS; another sort are armed with a cone containing Carcass composition, and are called CARCASS ROCKETS; a third sort are armed with a solid shot, and called SHOT ROCKETS.

Tubes of different lengths and constructions are fitted for firing this weapon from boats, and tubes with light frames for firing them on shore.

In calm weather and smooth water, rockets will range with tolerable correctness from boats. It must be remembered that, when the wind crosses the direction, the rocket will incline to windward, and must, therefore, be pointed somewhat to leeward of the object—the more so as the breeze may be stronger, and the range longer; also, with a fair wind rather less, and with an opposing wind rather more, elevation will be required than in a calm;—the reason of this is, the wind acts on the rocket stick as on a lever.

Rocket practice is not likely to be very certain when fired from boats, or vessels having much motion, because the rocket does not leave the

tube until some little time after it is lighted; the larger it is, the longer it hangs burning on the frame before sufficient force is generated to enable it to move off: this force continues to act up to a certain point; and, in consequence, the velocity of the rocket increases up to this point in its line of flight, which circumstance accounts for a very great penetration (nearly 22 feet in earth) some rockets were found to have made at about 1200 yards range.

Rockets may be useful when a landing takes place in presence of an enemy, since rocket-men can land with the first infantry, and commence firing before any species of ordnance can be brought into position to act against him. Rockets will be useful against cavalry; but not only so, for they would, it is presumed, when guns could not be brought up, be useful to dislodge an enemy from houses and villages, &c., which could not be approached by infantry alone, without a certain considerable loss of men, and no inconsiderable chance of failure, as experience too abundantly has proved.

The writer ventures an opinion from experience; that a skirmishing or desultory fire with rockets will almost always be found to be a mere waste of ammunition, serving only to encourage

an enemy, and to produce a bad moral effect on our own forces. Used against masses of infantry or cavalry in considerable quantities, it seems impossible but that they should be effective weapons.

Rockets were orginally designated by their weights, by Sir William Congreve. Those usually employed on service are of the following natures—viz., 32, 24, 12, 6, and 3 pounders.

RICOCHET FIRING.

By the above term, when used afloat, is meant, the causing shot to graze on the water short of the object, so that it may be reached by successive bounds or ricochets.

This definition will apply, with sufficient correctness, as far as regards the service of naval artillery: on shore, the meaning of the term is extended beyond this.

A gun fired from a lower deck, when laid point blank at the horizon, will generally make more than 18 ricochets before its extreme range be completed. This may not, perhaps, be an improper mode to fire shot at a cluster of row and gun-boats, and even small steam craft of a *slight scantling;* but when so doing, two circumstances should be kept in mind—1st. That causes, seem-

ingly of little moment, will produce considerable deflection from the line of direction, viz., shot grazing on a rough sea or on very shoal water, so that they may touch the ground; nay, even by the shot ricocheting on a rapid lee current, or on a lee tide crossing the direction of the range. 2d. The power of the shot as to penetration, after having made a certain number of grazes on the water; for as a shot evidently loses some force by every graze, it is desirable to know after *how many*, and under what circumstances of weight, elevation, and charge, it will retain sufficient force to penetrate a large ship's side? When the "Impregnable" returned to Gibraltar in 1816, from the attack on Algiers, and the effect of the enemy's shot on her was naturally an object of interest to professional men, it was perceived, that some shot had passed through her side, but some had lodged and did not perforate, and others had made indentures without even lodging. The impression on the minds of several persons then present was, that the shot which did not perforate had reached the ship after several ricochets.

In an extract from a memoir on Sea-Coast Batteries, it is stated, "that *all* ricochets at 2 or "3 degrees will cause but *little loss of force* to

" the larger shot;" also*, "those from 24 pounders " fired at 4 degrees will retain even more force " than requisite to pierce the side of a ship of the " line, at 300 toises and farther, however strong " she may be." Now, the range of a 24 pounder at 4 degrees cannot be *less* than 1500 yards; how then is it possible to hit a ship's hull at all, at 4 degrees, and distant 300 toises, (about 640 yards,) even by the first graze, much less by ricochets? This latter remark is clearly inconsistent with itself: it has been transcribed or quoted as an authority in the " Aide Mémoire," " Règles de Pointage abord des Vaisseaux," and in some other works, English as well as French, in most of which is recommended the practice of ricocheting shot, and in them is discussed at some length, the height to which shot bound, &c., but leaving untouched, or merely glanced at, the question as to diminution of force from the several grazes.

M. Paixhans, in his "Nouvelle Force Maritime," recommends to fire certain of his shot and shells " ricochant, roulant," &c., considering the force of the shot will be sufficient to penetrate after having made several rolls and ricochets.

* " Ceux de 24 sous 4 dégrès conservent encore plus de " force qu'il ne faut pour percer le flanc d'un vaisseau, tel " fort qu'il soit, à 300 toises et plus."

Experiments on the above subject may appear to be worth making, not very expensive, and would set an important question at rest.

Larger charges seem more favourable than smaller ones for ricochet practice on water, as they have been found to produce more numerous bounds or ricochets of the shot.

CONCENTRATION OF FIRE.

By this expression is meant, the delivery, or power to deliver at will from a ship, either at anchor or under sail, (within certain limits as to distance,) at one discharge, the shot from a whole broadside concentrated to a focus; or, at least, to within a small space on the object fired at, as on a ship or on a fort when a vessel may be running past it.

It is difficult to fix the era of an invention, or of a first application; but the earliest adaptation of the above principle to practice at sea is believed to have been made by Sir Philip Broke, on board His Majesty's ship "Shannon," and was explained to the writer a short time previous to the capture of the "Chesapeake" by that ship.

The following is the method, or at least the principle of the method, described to have been

followed in the "Shannon." There were *three points* on which the guns could be concentrated, and *one distance.* The points were, 1st, as much before the beam as possible; 2d. as much abaft it as possible; and 3d, *on* the beam: the distance was 300 yards. The ship being at anchor, the aftermost gun was pointed forward as much as possible; and in the prolongation of its axis a buoy was moored at 300 yards' distance; all the other guns of that side were then pointed at the buoy, and a mark made on the transom and rear axle of each gun-carriage; also, on the lower sill of each port, and on the deck, to correspond with those on the transom and rear axle-trees respectively; so that by these marks being made to correspond, the guns could promptly be brought into the same direction (that is, converged to a point before the beam 300 yards distant). The guns being thus converged before the beam, their axes were laid parallel with the horizon by means of a side scale or pendulum, or a graduated coin and pendulum; or by being pointed at the horizon by means of a tangent sight fixed at PB. As the range of a long gun fired in this manner will be 300 yards and more, it follows that the shot from a broadside so delivered, will meet in a vertical line drawn from the buoy upon which the guns

were concentrated; at a height less than that from which the guns were fired.

The foremast gun is then to be pointed aft as far as can be, and the buoy laid down in its prolongation at 300 yards, the deck, gun-carriages and port-sills being marked as before; the second point of concentration will be thus obtained. In like manner, the midship gun is pointed directly a-beam, and the other guns being concentrated on that in a similar manner, the third point of concentration is thereby produced.

It has been urged in favour of this system of concentration of fire, that its value does not depend on an absolute accuracy of judgment in respect of the distance from the enemy or object to be fired at; since, if, instead of 300 yards, the enemy were 350 or 250 yards, the shot in the first case would only diverge one-sixth of the distance of the base of the triangle, viz., one-sixth of the distance between the after and foremost of the guns, at most not more than thirty feet; and in the second case of error, the shot would strike the object before they converged in the same space (one-sixth of the base). Therefore, under such limits of error, and even greater, the shot of the broadside would be lodged in the hull of the enemy's ship somewhere. The "Chesapeake," when taken, ex-

hibited the effect of so many shot in a small space on the larboard quarter, that it seemed to have been produced by the application of the concentrated fire; but such, the writer was informed at the time, was not the case: it was supposed to have been the result of expertness acquired by the crew of the "Shannon" from frequent and industrious gun exercise and practice, together with the use of a dispart (at that time not universally fitted to guns); perhaps, much practice in general systems of firing had produced individual intelligence and expertness in the ship's company.

The method of concentrating fire has, however, since its introduction, undergone very great extension in its application, so much so, as almost to have altered its principle; thus the broadside may now be concentrated from any gun, and (within certain limits) to a given distance. This, it is believed, was effected on board the "Victory," by Captain the Honourable George Elliot, and much ingenuity, care, and labour must necessarily have been requisite to have perfected the application.

Triangle or quadrant boards were constructed (see fig. 13), containing a quarter of a circle, described from the apex of the triangle *a*, with a radius of about one foot, the arc, *c d*, being divided into degrees, or into points, half points, &c.

These boards are placed behind the gun on the deck, with the base, *e f*, parallel to the keel, and the centre of the circle, *a*, in the axis of the piece prolonged to the rear (*i. e.*, in the vertical plane in which the axis lies). During the time the gun is being trained, the board is moved also, in order that its relative position to the gun, as above described, may be preserved. The trigger line is held so as to coincide with the axis of the gun, prolonged to the rear, as *a h*; and when the line covers the given point, as *b*, the gun will be converged to the distance to which that point *b* may refer. The required point *b* will be different for each gun, and will be more distant from the centre point of the board *o*, as the said piece is more distant from the converging gun. The above points may be found by trial, when the ship is at anchor, by mooring buoys at the several distances to which it may be intended to converge the fire of the broadside at any future time, and then by marking on the board the points due to each gun; by which means it will be found how many points must be allowed at each distance for every gun, according as it may be removed from the converging gun; or this operation may be effected by calculation. There is another converging instrument fixed to the upper sill of each port, viz.—a

graduated arc, having a moveable limb, with a fine line attached, which is to be held over the axis of the gun: this method, however, is only applicable to guns whose carriages traverse on a pivot, as Captain Marshall's, and those of a similar construction. In order to render the practice of concentrating fire more perfect, it was considered important that each gun should move or traverse on a fixed point, with a view that round such point or centre an arc might be described, and accurately graduated, whereby the fire might be concentrated, not only at different distances, but also from any individual gun named as a director. For this purpose, as well as to secure a more easy, even, and certain movement in pointing pivoted gun carriages, such as those indicated by the late Sir William Congreve, in his "Elementary Treatise," &c., and that invented by Captain Marshall, were proposed.

The water-ways added to ships of war, of late years, in some degree interfered with pointing of guns; in consequence of which, a breast-piece, or sweep, was constructed, of such a curve, and so projecting inwards, that if the ends of the cheeks, or brackets, of the gun-carriage were made to abut on the curve during the act of pointing, the trucks would in no case jam against the water-ways, and

the most oblique pointing would be obtained which the size of the port and construction of the ship and gun-carriage might admit. Thus, by this simple, but valuable, adaptation (which it is believed is due to Captain the Honourable George Elliot, R. N.,) were certain inconveniences either avoided, or rendered as little as possible, and a greater facility of even and uniform pointing was obtained than existed before. There is in course of trial on board the "Excellent," a contrivance by means of which it seems intended to imitate the movement of pivoted gun-carriages with those of the ordinary construction, at least so far as to enable these latter to be traversed with some approach to certainty round a fixed point; also, by using an arc graduated from such fixed point as a centre, it is meant to obtain a more correct application for the concentration of fire, as is the case with pivoted gun-carriages.

Previous to concluding these pages, it is wished to observe, that the methods described to find and fix disparts are by no means such as should be used, except when regular artificers and instruments cannot be obtained, nor the guns taken on shore; the chief objects having been to explain the nature and the meaning of the term dispart, and to afford an easy and a ready method to affix

one in time of need. In all arsenals, disparts are, or should be, found *immediately* from the axis of the gun, and not *mediately* from its exterior parts. The land-service brass guns are admirably correct in all their graduations—they are marked by the government departments, where faithful work is to be expected.

And, further, it is more desirable than practicable that all guns in a ship should be capable of being elevated or depressed *in the port*, as many degrees as the ship is at any time likely to heel over; for suppose the ship heel 10°, and the guns could only be elevated 7°, and depressed 5°, in the ports, the evident consequence would be, that the weather guns could not be pointed *lower* than 5° of elevation, and the lee guns could not be pointed *higher* than 3° of depression, and the opponent might not be more than 300 yards distant; the result of fire delivered under such circumstances may readily be conceived. Much attention has been paid to this circumstance, and no doubt all that can be done either is, or will be, effected to remedy this inconvenience.

(*Note.*) Much valuable information, on the subject of ricochet firing *on shore*, may be obtained by the perusal of an article translated from the French, by Captain Sabine, of the Royal Artillery, published in the "Quarterly Journal of Science and the Arts," for October, 1826, page 113.

TABLE

Showing the Nature, Weight, Length, Diameter of Bore, Charge of Powder, and Range single shotted, of the various Description of Iron Ordnance.

The height of the Muzzle above the Level of the Plane is considered to be 8 feet, and the Piece elevated with the Quadrant.

Nature.		Weight.	Length.		Diameter of Bore.	Charge of Powder.		Range in Yards at						
		Cwt.	Ft.	In.	Inches.	lbs	oz.	PB.	1°.	2°.	3°.	4°.	5°.	
Guns	32 Prs.	63	9	7	6·41	10	10½	420	820	1170	1480	1730	1950	
		56	9	6	6·41									
		48	8	0	6·41	8	0	360	730	1050	1320	1540	1740	
		40	7	6	6·35	6	0	330	720	1020	1280	1500	1700	Windage decreased 0·06
		32	6	6	6·3	5	0	360	700	980	1230	1450	1640	Do. do. 0·11
		25	6	0	6·3	4	0	250	520	760	1010	1260	1500	Do. do. 0·11
			5	4										
	24 Prs.	50	9	6	5·823	8	0	400	800	1150	1440	1670	1850	
		48	9	0	5·823	8	0							
		40	7	6	5·823	8	0	380	780	1120	1400	1620	1800	
		33	6	6	5·823	6	0	280	560	830	1100	1350	1560	
	18 Prs.	42	9	0	5·292	6	0	400	780	1120	1400	1600	1780	
		38	8		5·292	6	0	380	760	1100	1370	1560	1730	
	12 Prs.	34	9	0	4·623	4	0	400	770	1100	1360	1540	1700	Solid Shot.
		29	7	6	4·623	4	0	380	760	1080	1330	1500	1650	
	9 Prs.	26	7	6	4·2	3	0	370	730	1050	1300	1460	1600	
	6 Prs.	17	6	0	3·668	2	0	360	700	1020	1260	1400	1520	
Guns	68 Prs.	60	8	0	8·05	9	7	360	660	950	1200	1430	1620	
		50	6	8	8·05	7	0	320	600	870	1100	1300	1480	
Carronades	68 Prs.	36	5	4	8·05	5	10½	300	580	840	1060	1240	1420	
	42 ,,	22	4	6	6·84	3	8	270	550	800	1000	1180	1350	
	32 ,,	17	4	0	6·25	2	10½	260	520	730	920	1100	1260	
	24 ,,	13	3	9	5·68	2	0	250	460	670	840	1000	1150	
	18 ,,	10	3	4	5·16	1	8	240	440	640	800	950	1100	
	12 ,,	6	2	8	4·52		0	230	400	600	750	880	1000	
Guns fired with Hollow Shot.	12 Inch	90	8	4	12·	12	0	280	570	800	1030	1250	1460	Hollow Shot 112lbs.
		84	9	4	10·	12	0	350	660	950	1210	1460	1700	Do. do. 82 ,,
	10 Inch	62	8	4	10·	8	0	280	570	820	1030	1250	1460	Do. do. 76 ,,
		57	7	6	10·	7	0	240	480	700	900	1100	1250	Do. do. 68 ,,

RANGES OF SEA SERVICE IRON MORTARS,

At 45°,

With various Charges of Powder and Dead Shells.

Charge.		1lb.	2lbs.	3lbs.	4lbs.	5lbs.	6lbs.	7lbs.	8lbs.	9lbs.	9½lbs.	10lb.	12lb.	14lb.	16lb.	18lb.	20lb.
Range.		Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.
	Cwt.																
13 Inch	100	—	690	—	1400	—	1900	—	2575	—	—	2975	3800	3860	3900	4000	4200
10 Inch	50	680	1340	1900	2500	2800	3200	3500	3800	3900	4000	—	—	—	—	—	—

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Fig. 1.

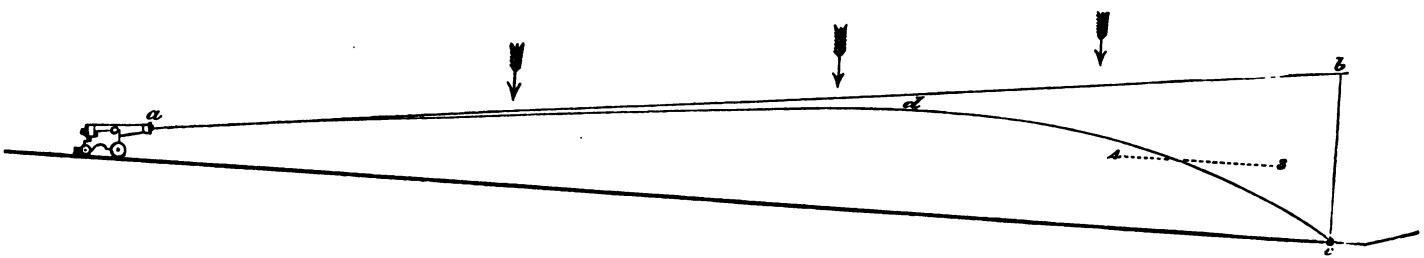
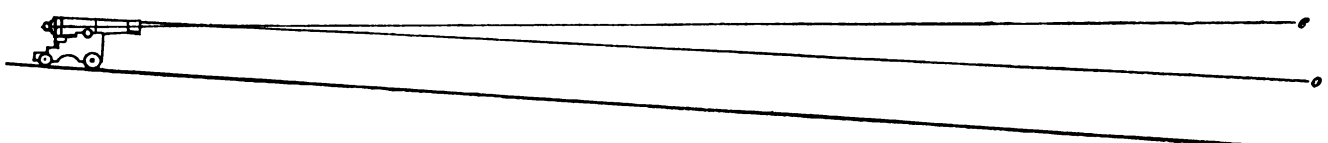


Fig. 2.



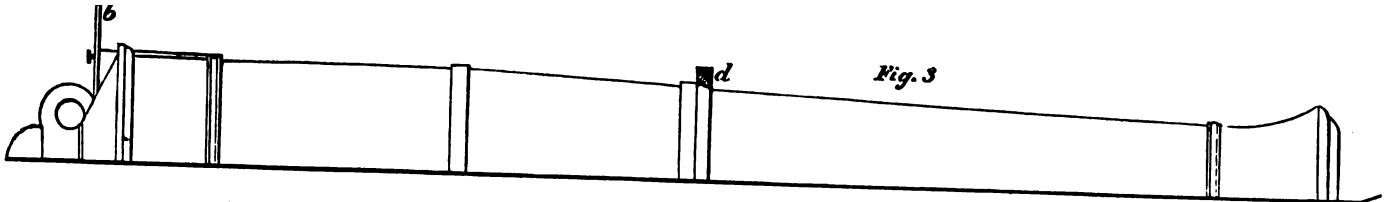


Fig. 3

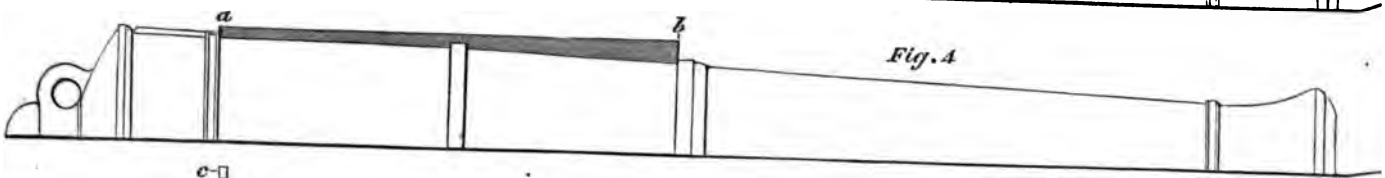
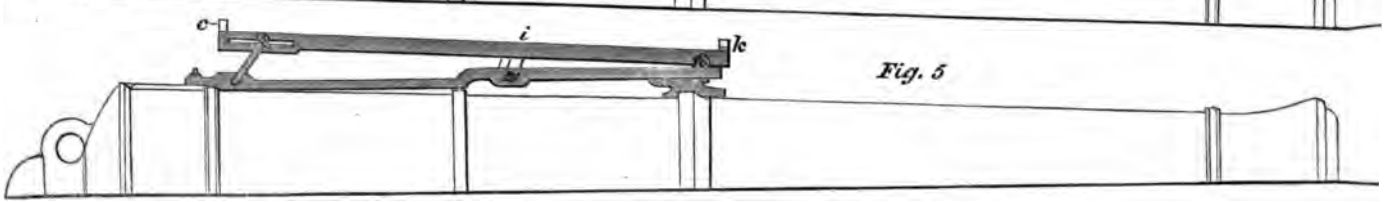


Fig. 4



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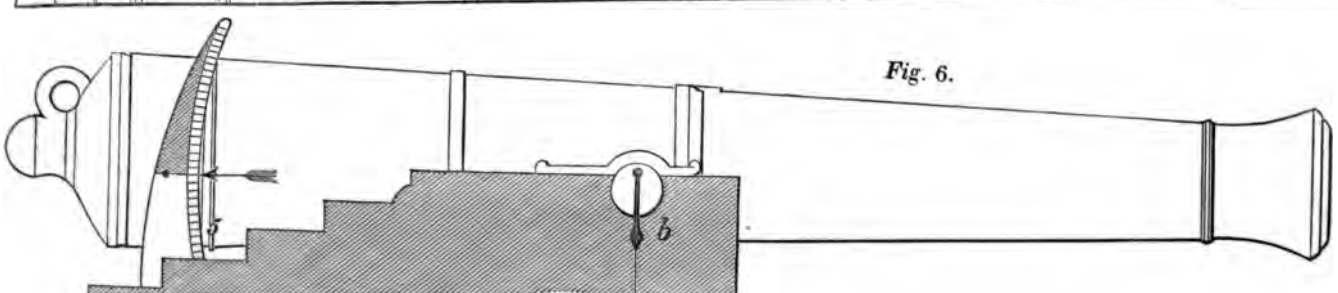
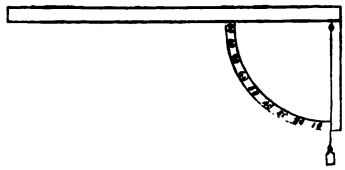


Fig. 6.

Fig 7.



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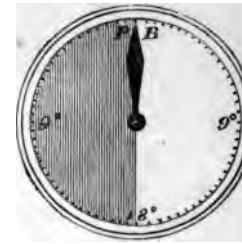

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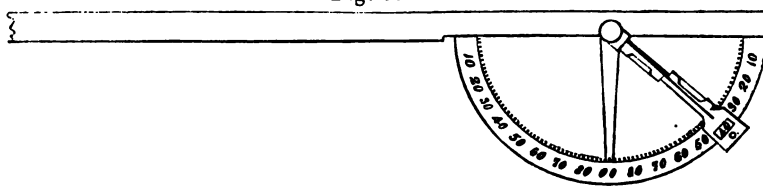


Fig. 13

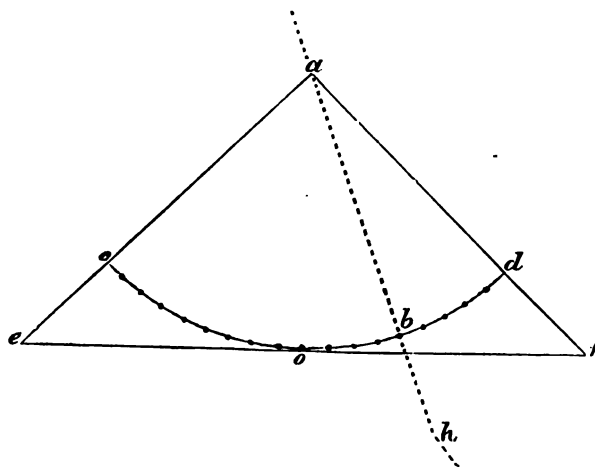
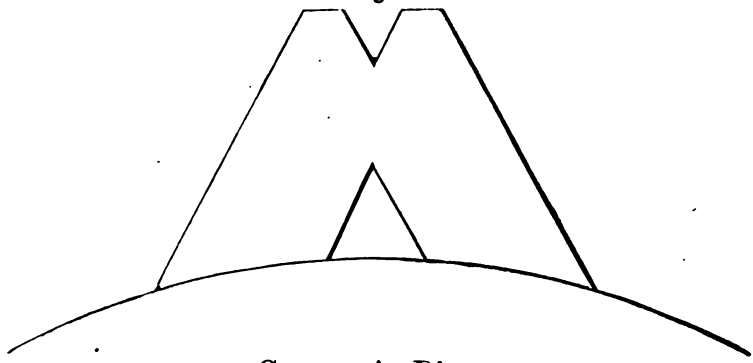
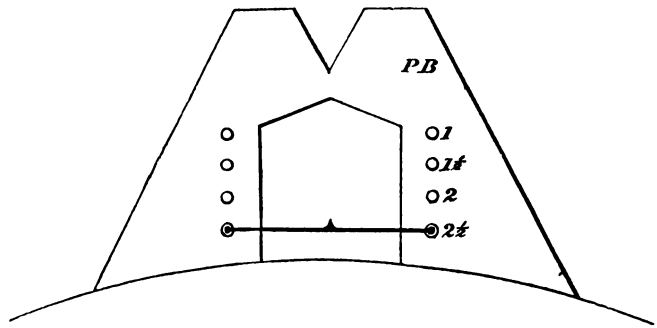


Fig. 10.



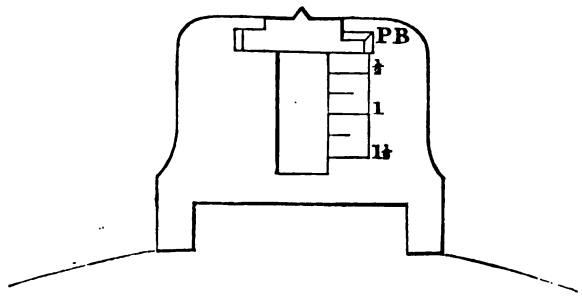
Congreve's Dispart.

Fig. 11.



Congreve's Improved Dispart.

Fig. 12.



Hookham's Sight.